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Review Article

Virtual Reality in Adult Patients Undergoing Neuraxial Anesthesia: A Scoping Review of Perioperative Psychological Outcomes and Patient Experience

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ABSTRACT

Background: Patients undergoing neuraxial anesthesia remain conscious during surgery and may experience perioperative anxiety and psychological distress. Virtual reality (VR) has been proposed as a non-pharmacological strategy to improve patient experience. This scoping review aims to map current evidence on VR effects on psychological and experiential outcomes in adults undergoing neuraxial anesthesia.

Methods: This scoping review was conducted in accordance with PRISMA-ScR guidelines. PubMed, Scopus, Web of Science, and Embase were searched up to November 2025. Studies investigating the use of virtual reality among adult patients receiving neuraxial anesthesia in the operating room were included. Information regarding study design, characteristics of the VR intervention, and reported outcomes was collected and summarized narratively.

Results: 13 studies involving 1,127 participants were identified, including 12 randomized controlled trials and one matched retrospective cohort study. Most interventions employed immersive VR during the intraoperative period. Anxiety and stress were the outcomes most frequently assessed, and a large proportion of studies reported significant reductions in anxiety following VR use. Evidence regarding pain reduction was variable and showed limited and inconsistent benefits across studies. Patient satisfaction and comfort were generally improved, whereas findings related to sedative requirements were mixed, with several studies reporting reduced sedative use.

Conclusion: VR appears to be a useful adjunct for enhancing perioperative patient experiences, especially with respect to anxiety reduction and patient satisfaction in adults undergoing neuraxial anesthesia. However, evidence concerning pain outcomes and medication use remains inconclusive, emphasizing the importance of conducting well-designed studies with standardized outcome measures.

Introduction

Neuraxial anesthesia, encompasses spinal, epidural, and combined spinal-epidural (CSE) techniques and is widely employed for lower abdominal and lower extremity procedures while allowing patients to remain awake throughout surgery[1]. Patients undergoing these techniques frequently experience peri-operative anxiety and stress, which may contribute to sympathetic activation, post-operative discomfort and reduced patient experience and satisfaction [2-3].

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Opioids and benzodiazepines are often used to alleviate perioperative anxiety, but they can have side effects such as nausea, respiratory depression, and prolonged recovery [4]. In recent years, greater attention has been directed toward non-pharmacological interventions, including hypnosis, music therapy, patient education, and distraction-based techniques [5-6]. Among these approaches, virtual reality (VR) has emerged as an immersive technology capable of promoting. By creating a calming three-dimensional (3D) environment, VR helps divert patients' attention away from surgical stimuli, which helps to reduce stress and psychological discomfort [8].

Recent studies have indicated that VR technologies can reduce anxiety and improve patient comfort during neuraxial anesthesia [8-10]. In addition, the use of immersive VR during the perioperative period has been associated with higher patient satisfaction and a more positive perioperative experience [11-12]. These findings suggest that VR may enhance psychological outcomes and overall perioperative experience without increasing pharmacologic burden.

Although VR has been evaluated in several systematic reviews involving general surgical settings and mixed anesthesia types [1-2], pediatric anxiety [3], and awake invasive procedures [4], none have specifically addressed the adult population undergoing neuraxial anesthesia, a setting in which patients are conscious and are thus particularly vulnerable to intraoperative psychological stress. Therefore, this scoping review aims to map and synthesize existing evidence on VR applications in adult patients undergoing neuraxial anesthesia and identify gaps for future research.

Methods

Protocol and Registration

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines were followed in conducting this scoping review [5]. Although the protocol was developed before the review process, it was not registered in PROSPERO.

Eligibility criteria

The eligibility criteria were defined a priori using the Population-Concept-Context (PCC) framework for scoping reviews. For this review, the PCC elements consisted of adult patients undergoing neuraxial anesthesia (Population), VR interventions targeting psychological or experiential outcomes (Concept), and perioperative care confined to the operating room setting (Context). The inclusion and exclusion criteria are summarized in (Table 1).

Information Sources and Search Strategy

A literature search was conducted across four electronic databases (PubMed, Scopus, Web of Science and Embase) to find studies that met the eligibility criteria.

Searches were completed on 2 November 2025 without applying date limitations. The search strategy was based on three conceptual fields: VR technology, neuraxial anesthesia techniques and adult patients. Synonyms within each concept were combined using Boolean operators, and the three concepts were linked to each other across databases. The complete search strategies for each database are available in Supplementary File 1.

Selection of Sources of Evidence

All records retrieved from the database search were imported into EndNote 21, and duplicates were removed before screening. Two authors (KK and TR) independently screened titles and abstracts according to the predefined eligibility criteria. Full-text assessment was then conducted by the same authors. Any disagreements at either stage were resolved through discussion with a third author (MS).

Table 1- Eligibility criteria

Criterion	Inclusion Criteria	Exclusion Criteria
Population	• Adult patients (≥18 years) undergoing neuraxial anesthesia: spinal, epidural, caudal, or CSE.	• Pediatric patients (<18 years) • Patients receiving general anesthesia, peripheral nerve blocks, or no anesthesia.
Concept	• Use of VR during the perioperative period to improve patient-centered experiential outcomes (e.g., anxiety, stress, pain perception, satisfaction).	• VR used solely for physiological/hemodynamic monitoring • VR used for training, education, rehabilitation, or non-patient applications.
Context	• Perioperative care limited to the OR environment during neuraxial anesthesia.	• Studies conducted outside the OR setting (wards, clinics, rehabilitation, pain clinics).
Publication Characteristics	• Original research articles including: RCTs, non-RCTs, pilot/feasibility studies. • Full-text available.	• Review articles, letters, commentaries, editorials. • Conference abstracts without full text. • Non-English publications.

• English language.	• Full text not available.
• search conducted up to November 2025.	

CSE: combined spinal–epidural; VR: virtual reality; OR: operating room; RCT: randomized controlled trial;

Data Charting Process

A data charting form was developed by two authors (KK and TR) to guide the extraction of all predefined variables. Both authors charted the data from each independently included study and compared entries for accuracy and consistency. Refinement of the charting form occurred iteratively throughout the process. Any discrepancies were resolved through discussion with a third author (MS). The complete data charting form is provided in Supplementary File 2.

Data Item

Data items extracted included study characteristics such as the first author, year of publication, country, study design, participant characteristics, type of neuraxial anesthesia, comparison groups, psychological or experiential outcome measurement tools, and key findings. Other variables related to the VR intervention were collected, including the type of VR, device, content, duration, and phase(s) of perioperative care.

Results

Selection of Sources of Evidence

A total of 1038 records were identified through database searching. After removing 261 duplicates, 777 records were screened by title and abstract. Of these, 732 records were excluded for not meeting the eligibility criteria. 45 full-text articles were assessed, and 32 were excluded after full-text review. Ultimately, 13 studies met the inclusion criteria and were included in this scoping review.

A summary of the identification, screening, and selection process is presented in the PRISMA flow diagram (Figure 1).

Characteristics of Included Studies

(Table 2) presents a summary of the key characteristics and extracted data from all studies included in this review. The sections below provide a more detailed explanation of the information outlined in (Table 2).

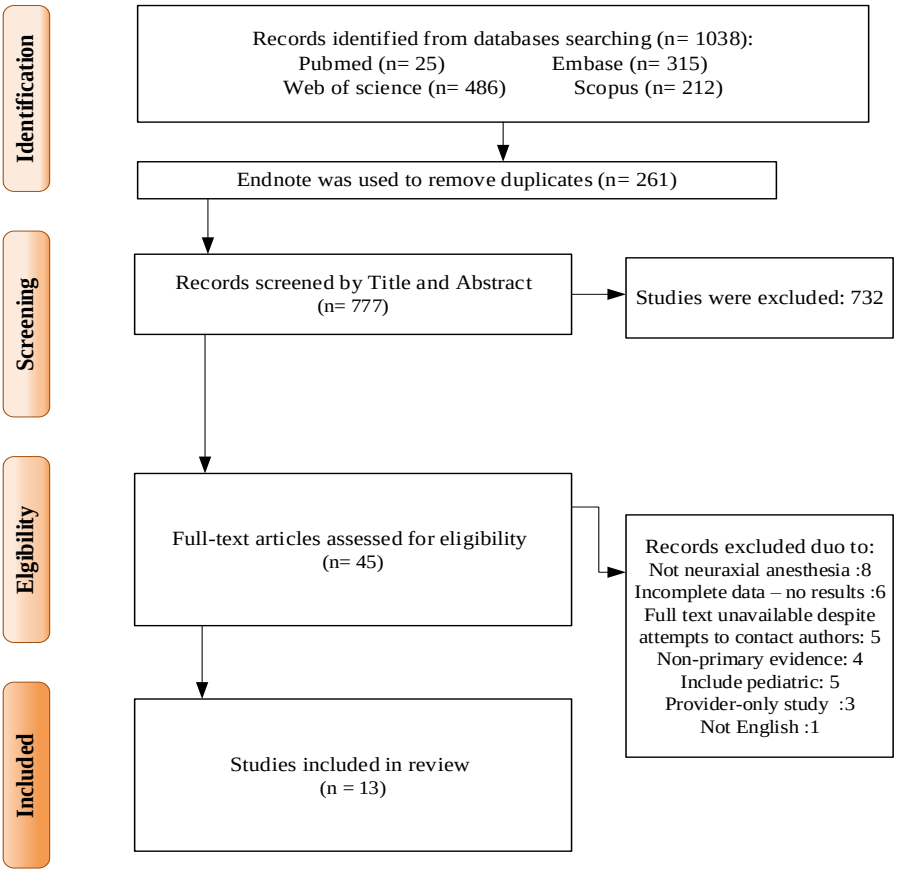

Figure 1- PRISMA flow diagram of the study selection process

Table 2- Characteristics of Included Studies

Author, country, year	Study design	Type of surgery	anesthesia	Outcomes	Key findings
Moharam, 2025 Egypt [8]	RCT	THA	SA	Anxiety, stress, patient satisfaction, pain	VR reduced perioperative anxiety, stress, pain, and satisfaction more than standard care.
Jain, 2025 India [19]	RCT	Elective hemorrhoidectomy	SA	Anxiety	VR reduced perioperative anxiety compared with standard care.
Ince, 2025 Turkey [17]	RCT	Cesarean section	SA	Anxiety, pain	VR effectively reduced anxiety and pain compared with standard care.
Xu, 2024 China [21]	RCT	Elective cesarean	SA	Anxiety, patient satisfaction, sedative/analgesic requirement	VR significantly reduced intraoperative anxiety, while patient satisfaction and sedative/analgesic requirements remained similar between groups.
Carella, 2024 Belgium [22]	RCT	TKA	SA	Sedation requirement, anxiety, pain, comfort, fatigue, patient satisfaction	VR reduced sedative use but showed no benefit for anxiety, pain, or satisfaction, while slightly improving comfort and reducing fatigue postoperatively.
Singh, 2024 India [9]	RCT	Knee replacement surgery	CSE	Anxiety, Stress-related hormones, and patient satisfaction	VR with music significantly reduced anxiety and stress-related hormone levels and markedly improved patient satisfaction.
Arifin, 2023 Indonesia [11]	RCT	lower abdominal or lower extremity surgery	CSE	Anxiety, patient satisfaction	VR surpassed midazolam for reducing perioperative anxiety, with higher patient satisfaction.
Barry, 2022 United States [20]	retrospective cohort Study	THA, TKA	SA (+/- nerve block)	Sedation/analgesic requirement, postoperative pain, PACU opioid use	VR reduced propofol use and suggested a calming or anxiolytic effect, with no differences in postoperative pain or other postoperative outcomes
Ahmedbesh, 2022 Saudi Arabia [23]	RCT	Elective cesarean section	Regional anesthesia	Emotional preoperative stress, anxiety, and patient satisfaction	VR significantly reduced stress/anxiety and increased maternal satisfaction postoperatively.
Turan, 2021 Turkey [10]	RCT	Lower abdominal anogenital, urologic, and lower extremity surgeries	SA	Anxiety, sedation requirement	VR significantly reduced intraoperative anxiety and the need for sedative medication, while preoperative anxiety remained similar between groups.
Şahin, 2020 Turkey [18]	RCT (Three-arm)	Knee arthroscopy	SA	Anxiety, patient satisfaction	VR did not reduce intraoperative anxiety but significantly increased patient satisfaction.
Huang, 2020 Australia [24]	RCT	THA, TKA	SA	Sedation requirement, patient experience (comfort, emotional state, symptoms and pain), patient satisfaction	VR did not reduce propofol sedation requirements and produced no differences in patient experience, emotional state, pain, or satisfaction.
Moon, 2019 South Korea [12]	RCT	Endoscopic urologic surgery	SA	Patient satisfaction, recall, pain, procedural comfort/movement	VR distraction produced significantly higher patient satisfaction and markedly reduced discomfort compared with midazolam sedation.

Geographical context

Three of the 13 studies were carried out in Turkey [6-8]. The remaining studies were conducted in India [9-10], the United States [11], Egypt [12], China [13], Belgium [14], Indonesia [15], Saudi Arabia [16], Australia [17], and South Korea [18] (Figure 2). All relevant studies were published within the past seven years (between 2019 and 2025), even though no date restrictions were applied (Figure 2).

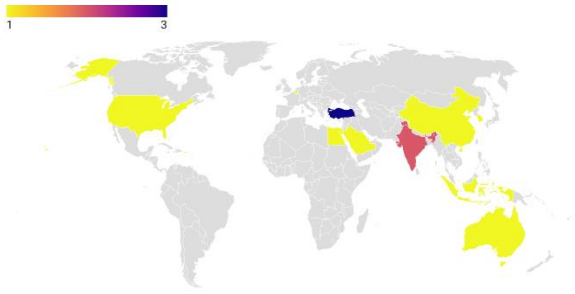

Figure 2- Countries contributing to the included studies, shaded by publication count

Study design

12 of the 13 studies were RCTs, including both two–arm and three–arm designs. One study utilized a matched retrospective cohort design [11].

Mean ages ranged from approximately 31 to 65 years in individual studies, while the overall age range extended from 18 to 93 years. Individuals of all genders were represented. The study sample comprised adults undergoing elective surgical procedures performed under neuraxial anesthesia.

The surgical specialties varied, primarily encompassing orthopedics (total hip and knee arthroplasty, knee replacement, and knee arthroscopy), obstetrics (cesarean section), general surgery (hemorrhoidectomy), and urology (endoscopic urologic and lower abdominal/anogenital surgeries). In four studies, participants were categorized as American Society of Anesthesiologists (ASA) class I–III [10, 12, 14, 18]; one study included those with ASA class II-III [11], three studies included those with ASA class I–II [8-9, 15], and one study included those with ASA class II [13]. ASA status was not reported in four studies [6-7, 16-17].

Type of anesthesia

Spinal anesthesia was utilized in 11 of the 13 studies. One study used spinal anesthesia with or without a supplemental nerve block [11]. The remaining two studies utilized CSE anesthesia [10, 15]. One study reported the use of regional anesthesia, which in the context of a cesarean section likely refers to a neuraxial technique such as spinal or epidural [16].

Comparison group

All thirteen studies used a controlled design. In eight studies, standard perioperative care without any additional structured intervention was the comparator [6, 8-13, 16]. One trial employed a three-arm randomized design, including a standard care control group, a VR intervention group, and an additional active comparator group receiving progressive muscle relaxation (PMR) training [7]. Two studies compared VR with midazolam-based sedation [15-18], while one study evaluated virtual reality hypnosis (VRH) as an adjunct to standard care with on-demand midazolam administration in both groups [14]. One study assessed VR as an adjunct to propofol patient-controlled sedation (PCS), comparing sedation requirements between PCS-only and PCS with VR groups [17].

Characteristics of the VR Interventions

The characteristics of the VR interventions used in the included studies are summarized in (Table 3). Immersive VR (IVR) was the predominant modality, used in 11 studies, while two studies employed specialized formats, VRH [14] and music-based VR (M-VR) [10]. VR systems and devices were highly variable, ranging from commercially available head-mounted displays to purpose-built systems for hypnosis-based VR. VR systems and devices were highly variable, ranging from commercially available head-mounted displays to purpose-built systems for hypnosis-based VR. Most interventions featured calming natural landscapes combined with background music or guided narration. Tailored interventions included a custom educational and meditation video, patient-selected audiovisual content, and a prerecorded hypnosis session [9,21-22]. Regarding timing, the intervention was administered intraoperatively in 11 studies. In two others, a combined preoperative and intraoperative approach was applied, where VR started before anesthesia induction and continued into surgery [10, 12]. VR exposure duration ranged broadly, with some studies using fixed-length, session-based interventions lasting 15 to 120 minutes, while others implemented procedure-long protocols in which VR was maintained throughout the surgical intervention. In one study, VR was initiated approximately one hour preoperatively and continued intraoperatively [10].

Outcomes

Anxiety and Stress

Anxiety and/or stress was assessed as a primary or secondary outcome in 10 studies using a range of validated instruments. The State–Trait Anxiety Inventory (STAI) and its variants were the most frequently employed measures [6-10, 12, 15]. Additional tools included the Visual Analog Scale for Anxiety (VAS-A)

[8, 13], the Perceived Stress Scale (PSS-10) [12], and anxiety-specific Numerical Rating Scales (NRS) [14].

Table 3- Characteristics of the VR Interventions

Author, country, year	Device	Content	Duration	Phase(s) of Care
Moharam, 2025 Egypt [8]	VR Glasses with an audio headset	A peaceful, natural environment with soft music	15 min	preoperative & intraoperative
Jain, 2025 India [19]	JioDive VR Headset	Meditation and nature-based videos	30 min per session	intraoperative
Ince, 2025 Turkey [17]	Samsung Gear VR glasses	Relaxing videos with a music background (nature, seaside, submarine images)	20 to 25 minutes on average per session	intraoperative
Xu, 2024 China [21]	PICO Neo 3 VR Headset Type: IVR	Custom evidence-based video: C-section education & psychologist-guided meditation for anxiety.	30.5 min per session	intraoperative
Carella, 2024 Belgium [22]	Oncomfort Sedakit X2 (HypnoVRSAS)	Prerecorded hypnosis session (120 min underwater experience)	120 min	intraoperative
Singh, 2024 India [9]	IRUSU MONSTER VR Headset + Sony WH1000XM4 Noise-Canceling Headphones	Patient's choice of video with music	~ 1 hour	Preoperative & intraoperative
Arifin, 2023 Indonesia [11]	Oculus Quest VR Content: Meditative 3D videos	Meditative 3D videos from real VR Fishing software, and listened to soothing nature sounds.	30 min per session	intraoperative
Barry, 2022 United States [20]	PICO G2 4K Enterprise Goggles + Bose Quiet Comfort QC 35 Noise-Canceling Headphones	4 different visual content environments created by Hypno VR (voice-guided relaxation techniques/ sounds	Duration of surgery	intraoperative
Ahmedbesh, 2022 Saudi Arabia [23]	Oculus Rift S VR Headset	3D natural landscape videos with a choice of calm Quran recitation or relaxing music	Duration of surgery	intraoperative
Turan, 2021 Turkey [10]	BOBO VR Z4 Glasses	A nature documentary prepared for VR technology	Duration of surgery	intraoperative
Şahin, 2020 Turkey [18]	VR goggles used with a smartphone	3D nature video documentaries with calming background music	55 min per session	intraoperative
Huang, 2020 Australia [24]	Samsung Gear VR or Oculus Rift DK2	Eden River (river journey) or Iceland (Arctic tundra) software with classical music	Duration of surgery	intraoperative
Moon, 2019 South Korea [12]	Head-mounted display (Samsung Galaxy 7.0) + earphones	The "Aqua 30" program featured an underwater scene with relaxation/meditation narration.	30 min per session	intraoperative

Specialized metrics such as the Novel Visual Facial Anxiety Scale (NVFAS) and the Brief Measure of Emotional Preoperative Stress (B-MEPS) were applied in a single investigation [16].

Two studies also assessed objective biomarkers of stress, including serum cortisol levels [8] and both cortisol and adrenocorticotropic hormone (ACTH) levels [9], and reported significant reductions in these stress-related hormone levels among participants receiving VR compared with controls.

Findings suggest a consistent trend toward reduced anxiety following VR interventions. Eight studies reported significantly lower anxiety levels in the VR groups compared with control conditions across a range of surgical settings (8/10, 80%) [6, 8-10, 12-13, 15-16]. No statistically significant advantage of VR was observed in two studies (2/10, 20%) [7, 14].

Pain Perception

Pain was assessed as a primary or secondary outcome in six studies, yielding heterogeneous results [6, 11-12, 14, 17-18]. The primary instruments for its measurement were the NRS [11-12, 14, 18]. Pain was specifically measured using the Visual Analog Scale (VAS) and the Verbal Category Scale (VCS) in one study [6]. Haung et al. assessed pain using the modified Quality of Recovery Survey (QoR-40) [17].

A reduction in pain scores associated with VR intervention was reported in two studies: for intraoperative pain during cesarean section [6] and for perioperative pain following total hip arthroplasty [12] (2/6, 33.3%). In contrast, three studies found no statistically significant difference in pain scores between the VR and control groups (3/6, 50%). This null effect was observed in studies comparing VR to midazolam sedation [14], to patient-controlled sedation with propofol [17], and in the postoperative period following total hip and knee arthroplasty [11]. Although procedural pain was assessed using an NRS in one study, no significant pain-related effect of VR was reported, as pain scores were minimal in both groups (1/6, 16.6%) [18].

Patient Satisfaction and Comfort

Patient-reported satisfaction was a principal endpoint in most investigations. including study-specific scales such as a 3-point satisfaction scale [12, 17], VAS for satisfaction [7, 13], Likert-type satisfaction scores [14-15, 18], and validated domain-specific tools such as the Birth Satisfaction Scale-Revised (BSS [16]) and the Perceived Stress Scale (PSS) adapted for satisfaction measurement [10].

Six studies reported significantly higher satisfaction with VR (6/9, 66.6%) [7, 10, 12, 15, 16, 18], whereas three studies found no significant between-group difference (3/9, 33/3%) [13-14, 17].

Patient comfort or discomfort was specifically evaluated in three studies. Two studies reported improved comfort or reduced discomfort with VR compared to midazolam sedation [18] or standard care (2/3, 66.6%) [14]. In contrast, Haung et al. found no significant difference in patient comfort between VR and patient-controlled sedation with propofol (1/3, 33.3%) [17].

Sedation and Analgesic Requirements

Five studies quantified the effect of VR intervention on the requirement for sedative and analgesic medications during procedures under neuraxial anesthesia. The findings on sedative use were mixed. Three studies reported a reduction in sedative requirements [8, 14] or propofol requirements in the VR group [11] (3/5, 60%). In contrast, two studies found no significant difference in sedative consumption when VR was compared to patient-controlled sedation with propofol [17] or to standard care [13]. Concerning analgesic use, two studies found no significant intergroup difference in analgesic needs [11, 13]. The primary tools for measuring these outcomes were intraoperative medication logs documenting dosages of midazolam, propofol, fentanyl, and other agents, as well as postoperative records of opioid consumption in oral morphine equivalents (OME).

Discussion

To our knowledge, this scoping review provides the first comprehensive synthesis of research on the application of VR to improve perioperative patient-centered experiential outcomes for patients undergoing neuraxial anesthesia. VR has been investigated as a nonpharmacological method to improve the perioperative patient experience [19-21]. Overall, the findings of this scoping review indicate that VR is most frequently linked to lower levels of perioperative stress and anxiety in patients receiving neuraxial anesthesia. On the other hand, there was limited and inconsistent evidence supporting VR's ability to reduce pain. Although impacts on secondary outcomes such as sedative requirements varied, improvements in patient satisfaction were also often reported.

Reduction of anxiety and stress was the most consistent psychological benefit of VR across the included studies. Most studies reported reduced levels of perioperative anxiety, suggesting the role of immersive and relaxation-oriented VR as an anxiolytic [9-11,17-19,21,23].

These benefits, however, were not observed consistently across all studies. For instance, Şahin et al. reported that anxiety levels increased toward the end of surgery in all groups, suggesting that intraoperative factors or the timing of outcome assessment may have attenuated the anxiolytic effects of VR. In addition, baseline differences in anxiety levels and the absence of pharmacological anxiolysis may have limited the ability to detect a differential effect between groups [18]. Similarly, in the study by Carella et al., potential differences in self-reported anxiety may have been obscured by pharmacological sedation, as midazolam was available to participants in both study arms, despite lower sedative use in the VR group [22]. These findings emphasize the importance of study design, comparator conditions, and the timing of outcome assessment when evaluating the anxiolytic effects of VR.

Previous reviews have suggested that VR may help reduce perioperative anxiety across a range of surgical settings. Asiri et al. reported consistent reductions in perioperative anxiety [13], whereas Li et al. and Alimonaki et al. examined preoperative anxiety in elective procedures and generally reported positive outcomes [7,13]. Li et al. further noted that distraction-based VR was more effective in pediatric populations, while exposure-type interventions, including natural scenes and calming sounds, appeared to produce greater benefits in adults [6,28-30]. Most of the studies included in our review used similar VR content consisting of natural scenery combined with calming auditory elements [8,10-12,17-20,23-24], which may have contributed to the consistent anxiolytic effects observed. By focusing exclusively on neuraxial anesthesia, our

review provides a more specific understanding of the role of VR in awake surgical settings.

The analysis showed that evidence regarding the effect of VR on pain was heterogeneous, with most studies finding no meaningful difference between the VR and control groups and only a small number reporting a significant reduction in pain intensity. This variability persisted even across similar surgical settings, such as total hip and knee arthroplasty, where both positive [8] and null effects [12,20,22,24] on pain intensity were reported. This finding may be explained by the physiological characteristics of neuraxial anesthesia, in which effective sensory blockade markedly attenuates nociceptive input and results in low baseline pain intensity, thereby limiting the potential for additional reductions that could be detected through cognitive interventions such as VR. In this context, a floor effect is likely, as pain intensity is already minimized by the anesthetic technique itself, whereas VR primarily influences pain through central cognitive–affective mechanisms, including distraction and mindfulness-related neural processes [31-32].

Similar results were reported in a randomized controlled trial involving patients undergoing hand surgery under ultrasound-guided regional anesthesia, in which no significant reduction in pain intensity was observed when VR was used during block placement or the surgical procedure [33]. Collectively, these findings suggest that, in the presence of effective sensory blockade, the limited impact of VR on pain intensity may be attributable to a floor effect and the predominance of cognitive–affective modulation rather than ongoing nociceptive input.

Several systematic reviews have demonstrated that VR can reduce pain intensity in a range of surgical and procedural settings. However, the analgesic effectiveness of VR appears to depend on factors such as the clinical context, the timing of the intervention, and the severity of baseline pain. In patients undergoing total knee arthroplasty (TKA), Esteban-Sopeña et al. reported a modest reduction in short-term postoperative pain following VR use, although the certainty of the evidence was low and substantial heterogeneity was noted [34]. Likewise, Ding et al. found lower postoperative pain scores across different surgical procedures, with the observed benefits being largely confined to postoperative settings where effective sensory blockade was not present [35].

Most studies included in the current review reported higher levels of patient satisfaction and perceived comfort among individuals receiving VR, even when no significant reductions in pain or anxiety were observed [18]. These findings suggest that VR technology may enhance the overall patient experience through mechanisms that differ from traditional clinical outcomes, such as pain and anxiety scores.

During regional anesthesia, patients remain awake and are exposed to various environmental stressors; therefore, satisfaction and comfort are strongly influenced by cognitive and experiential factors, including sensory distraction, perceived control, and patient engagement [36]. Even when pain-related outcomes show little or no significant improvement, VR may enhance these aspects of the patient experience by reducing exposure to visual and auditory stimuli in the operating room and fostering immersive engagement, ultimately contributing to higher levels of patient satisfaction.

The effect of VR on sedative requirements was inconsistent across the studies included in this review. While some studies reported reduced use of sedative agents, others found no significant difference compared with standard care. This variability may reflect the primary influence of VR on cognitive and affective domains, including anxiety reduction, attentional engagement, and perceived control, rather than on nociceptive processing.

In line with this interpretation, a recent systematic review by Zako et al. reported that immersive VR significantly reduced intraprocedural sedative requirements; however, its effects on opioid consumption remain uncertain, particularly in settings where regional anesthesia is not used [37]. Taken together, these findings suggest that the benefits of VR may be more pronounced in reducing sedative requirements during awake procedures, whereas its analgesic effects appear to be less consistent.

Several limitations should be acknowledged. First, there was substantial heterogeneity across the included trials with respect to surgical procedures, VR content, timing of intervention, and outcome measures, making quantitative data synthesis challenging. Second, variability in the reported effectiveness may be attributable to the different methods used to assess subjective outcomes, including anxiety, pain, and satisfaction, across studies. Third, evidence for certain outcomes, such as pain reduction and analgesic requirements, was limited and inconsistent and should therefore be interpreted with caution. Moreover, because this review focused exclusively on neuraxial anesthesia, the generalizability of the findings to other anesthetic settings may be limited. Nevertheless, this focused scope can also be considered a strength, as it provides a more targeted evaluation of awake surgical environments.

Future research should also be conducted in a way that minimizes the substantial variability in the results of existing studies by using standardized and patient-centered outcome measures to assess the effects of the intervention on domains such as pain perception, anxiety, satisfaction, and sedative requirements. More

consistency in the reporting of the timing and duration of the intervention and clearer characterization of the surgical and anesthetic contexts should also be sought. Further, well-designed research studies should be conducted to explore the context-related effects of VR interventions within neuraxial anesthesia settings with respect to experiential and physiological outcomes.

Conclusion

This scoping review highlights the increasing potential of virtual reality technology as an element of patient-focused care during procedures conducted under neuraxial anesthesia. The available research suggests that virtual reality has the potential to meaningfully enhance experiential outcomes such as patient anxiety, comfort, satisfaction with care, and sedative requirements, even if results regarding pain levels remain inconsistent. As such, this review underscores the significance of contextual factors in shaping patient outcomes. Further high-quality research is necessary to clarify the potential of virtual reality technology to enhance patient experience during awake procedures.

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